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**Standard Operating Procedures for the Nonlinear Biodynamics
Laboratory**

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**Standard Operating Procedures for the Nonlinear Biodynamics
Laboratory**

by

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Report

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I would like to acknowledge Dr. Abraham and Dr. Dingwell for working with me as I determined my interests in the academic setting. I appreciate Dr. Dingwell taking me into the Nonlinear Biodynamics Laboratory, and giving me an opportunity to experience research first-hand, even though I realized it turned out to not be something I wanted to pursue. This opportunity helped me narrow in on my career goals, and the creation of this report allowed me to apply all the effort I put into getting the lab set-up toward a concrete deliverable that will be of use to graduate students going forward.

Abstract

Standard Operating Procedures for the Nonlinear Biodynamics Laboratory

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The University of Texas at Austin, 2010

Supervisors: Jonathan Dingwell and Lawrence Abraham

After having worked in the Non-Linear Biodynamics lab for a few months, I determined that conducting original research is not where my true interests lie. Through this process, however, I learned a great deal about the equipment and systems that are key elements in the research process for projects that are conducted in this lab.

A current need in the lab is a document of standard operating procedures. Such a document would have the primary purpose of smoothing the transition of new graduate students entering the lab, so they could learn the processes and basic system operation quickly in order to be up to speed with the more “veteran” members of the lab.

Aside from the above primary goal, a secondary goal of writing this SOP document is to create a standardized method for the organization of research projects being conducted in the lab. This will allow for simpler archiving of major grant-funded projects, and will also provide a suitable place for other research projects that are not as formal in nature.

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CHAPTER 1: SETTING UP A NEW PROJECT

To facilitate collecting data for organized research projects in a manner that will be coherent across projects and investigators, the Nonlinear Biodynamics lab (NoBi Lab) has developed a standardized protocol for data collection. This “Standard Operating Procedure” (SOP) describes how to set up a new project in that database.

DATABASES FOR PROJECTS IN THE NOBI LAB

The Vicon data collection software (“Nexus”) is designed with certain built-in data management capabilities. The “Data Management” tool is simply a database system. Due to the potential for a large amount of data in each project, it makes most sense to have a new database for each large project in the NoBi Lab. In this way, we can better keep track of how data are collected and organized across different projects and investigators.

All databases will be located in the C drive on Kanga. Each database was designed to incorporate a total of 3 levels, each nested within the level above. You can see these levels in the “Data Management” once you have opened Nexus:

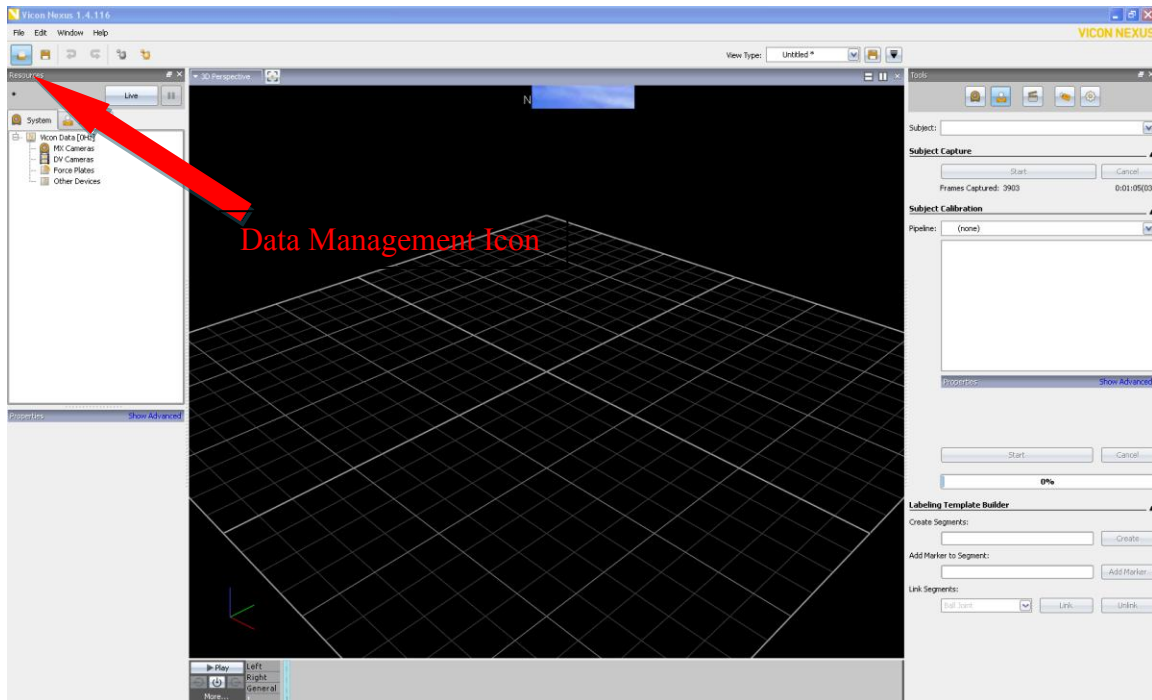


Figure 1. Data Management.

The three hierarchical levels of a database are as follows:

- ⇒ “Test Date” (designated by a green dot in the top left side of the database)
- ⇒ “Patient/Subject” (designated by a yellow dot)
- ⇒ “Session” (designated by a gray dot)

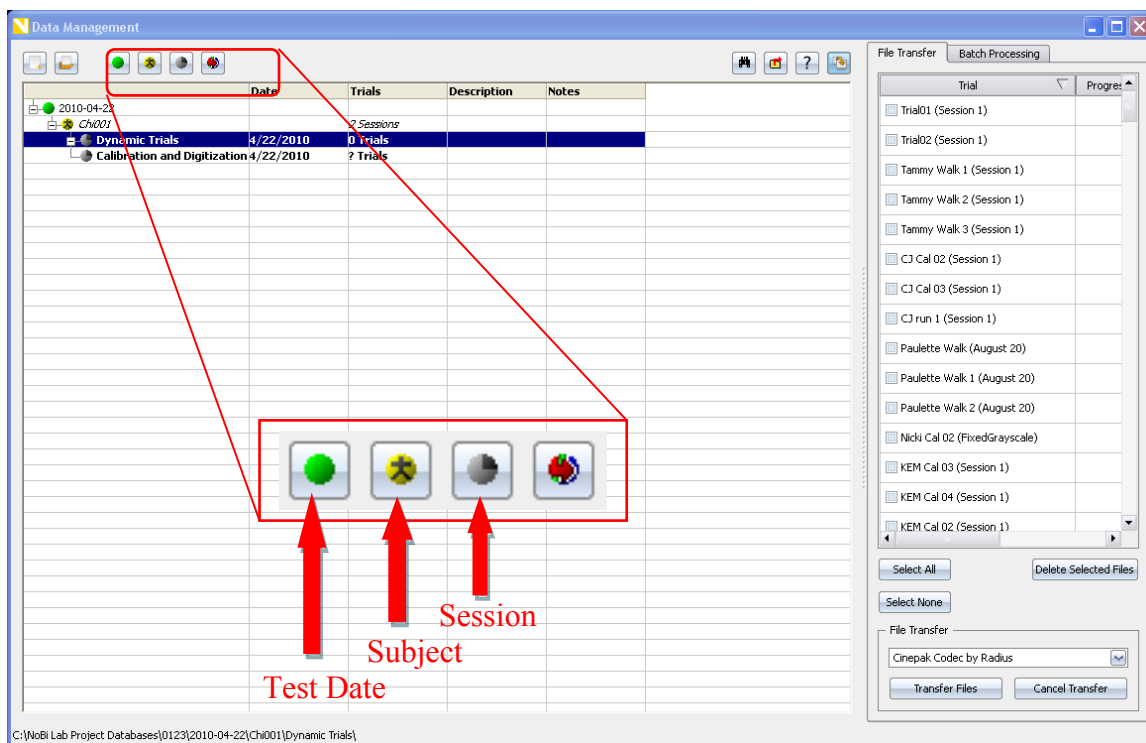


Figure 2. Hierarchical levels.

If there are multiple *groups* which need to be tested, these group names will need to be incorporated into the Patient/Subject level. For example, if conducting a study that is comparing the kinematics of Chi Runners to a separate control group of “normal” runners, your patients/subjects will have titles “Chi001” for the first subject in the Chi Running group and “Control001” for the first subject in the control group.

If there are multiple *conditions* for which any given subject must be tested, these condition names will need to be incorporated into the Session name. For example, if conducting a study that is evaluating variability of gait kinematics when a person is walking normally versus when they are forced to take longer steps or shorter steps, your

session names will have titles similar to “Normal Steps,” “Longer Steps,” “Shorter Steps.”

The first session for any given subject will be the “Calibration and Digitization Trials”. Your next session will be either the first condition name, or if you do not have multiple conditions, simply name this session “Dynamic Trials.” This includes all the trials from which you wish to extract data at a later time. Note: When you create a new session, it will be placed above any earlier sessions in the Data Management screen (reverse chronological placement of sessions). Note: Once you start collecting trials, each trial must also be identified first by condition if that pertains to your study, as described above. So, the specific trial name for a trial under the “Normal Steps” condition/session would be “Normal Steps Trial 001.” The most efficient way to name a trial is under the Capture tool in the main Nexus page, but you can also rename them after the fact in Data Management. It is not imperative that all projects utilize the exact same naming conventions. What is important is that you are consistent with naming conventions once you begin, and that they still follow the general hierarchy set out above.

WHEN AND WHERE TO CREATE A NEW PROJECT:

A new project should be created for any new or different *organized research experiment* that is intended to eventually lead to publication in some form. All projects in this category will be housed in the “NoBi Lab Projects Database” folder on the C drive.

Examples include:

- Your primary thesis or dissertation research project, including pilot data
- Any project related to a specific funded grant

- Any other project for which you intend the results to lead to eventual journal or conference publication.

A new project should NOT be created for any *smaller, non-specific data collection events* that do not fit into any of the above categories. A folder parallel to the “NoBi Lab Projects Database” folder, called “Misc Project Databases,” exists for such projects. Examples of these kinds of projects include:

- Small-scale class projects (unless specifically part of an organized project, as defined above)
- Testing of setups and / or equipment, etc. (unless specifically part of an organized project, as defined above)
- Projects for collecting pilot data for grant applications
- Any other small projects not affiliated with any larger organized project

If you wish to collect pilot data for your thesis / dissertation, you should set up one database for your full project and collect your pilot data within that single project. This is easily done by setting up your Project and then simply adding the pilot group designation to your patient/subject number (Example: “Pilot-Chi001”). If you are unsure which database your data should go into, consult Dr. Dingwell before setting up your project.

HOW TO CREATE A NEW NOBiLAB PROJECT:

Follow these simple steps:

1. Obtain a project number (if applicable) from Dr. Dingwell.
2. Log on to Kanga and open Nexus.

3. If you hold the mouse over the left-most icon in the main Nexus window, you will see that it is named “Data Management.” Click the icon.
4. If you hold the mouse over the left-most icon in the Data Management window, you will see that it is named “Create New Database.” Click the icon.
5. A pop-up window will appear, titled “New Database.” There are fields for *location*, *name*, and *description*.
6. Click the button with the ellipses, located to the right of the *location* field, to browse for the root folder.
7. Navigate to the “Local Disc (C:)” level.
8. Select the appropriate root folder:
 - a. If this is an *organized research experiment* as described above, select the “NoBi Lab Project Databases” folder as your root folder.
 - b. If this is *smaller, non-specific data collection events* as described above, select the “Misc Project Databases” folder as your root folder.
9. Next, name your project:
 - a. If this is an *organized research experiment* as described above, the name of your project MUST be the project number given to you by Dr. Dingwell, and it should be in the form “P#####”. (Example: P0123).
 - b. If this is *smaller, non-specific data collection event* as described above, you may name it what you wish, so long as it makes logical sense and will be clearly differentiated from other projects that will be housed in that same folder.
10. Provide a 1-5 word *description* of the project. This will aid you if you are running multiple experiments at the same time, and you can’t remember which is

which based on the project number alone. An example of a succinct, yet clear description is: Bob Smith's Thesis: Tripping.

11. Select the database template you wish to use. For all projects in the NoBi Lab, you will use the "*insert name here*" template.
12. Click the "Create" button.
13. Now you must setup the system for your specific needs. This is done under the "System" tab at the top left of the main Nexus page. A complete system configuration includes parameters for all data collection devices the lab is currently set up with. This includes:
 - a. MX Cameras
 - b. DV Cameras
 - c. Beltec Force Plate
 - d. Analog EMG

In almost all cases, you should start by selecting the system configuration named "NoBi Lab Full Configuration" from the drop-down menu. This is because it is already set up to include all four of the above data collection devices, so it's got everything you could need. Even if you won't be using all those collection devices, it will not cause any unnecessary overload on the system because you simply will not turn on the power supply to those devices if you are not using them.

Once you have selected the "NoBi Lab Full Configuration," you will make any customizations and RESAVE the new configuration with your project name.

- e. Go to System → System Configuration.

- f. Create a new System Profile by clicking the “New” button. Give your profile the same name as your project (e.g. P0003). Click “OK” twice.
- g. Go to System → Video Setup. Choose the video sampling frequency appropriate for your project. Click “OK”.
- h. Go to System → Analog Setup.
 - i. Choose the analog sampling frequency appropriate for your project. Do not press Enter.
 - ii. Turn on the analog channels you wish to collect. You may rename the EMG channels to reflect the muscles collected.
 - iii. ***Do NOT*** change any of the other settings (e.g. analog channel gains, offsets, etc.) unless you have a VERY good reason to do so and unless you have cleared these changes with Dr. Dingwell FIRST!!!
- i. Click “OK”

CHAPTER 2: SETTING UP A NEW PROJECT

Every project will differ in terms of what dependent measures you plan to extract from the raw data you collect. But the process for collecting the data is essentially the same, regardless of how many markers you use. For this section, we will assume you will be using one of the marker sets already created in our VICON system. If you ever need to create a new marker template for a project, that process will be addressed in a later chapter.

TURNING ON THE VICON MOTION CAPTURE SYSTEM

1. Turn on the power button on the MX Ultramet (large black box) in the blue locker to the side of the desk that holds Kanga.
2. If you will be using other data collection devices for your project, turn these on as well (example: EMG or force plate).
3. Log into Kanga and click on the VICON Nexus icon on the desktop.

SELECTING AND CUSTOMIZING THE SYSTEM CONFIGURATION

1. Select the "NoBi Lab Full Configuration" from the drop-down menu. The MX Cameras, DV Camera, and Force Plate are all set as they need to be.
2. If you need to collect EMG from specific muscles, open the "Other Devices" folder, select "Analog EMG", and then rename each of the channels to the specific muscle names you require. Save this configuration with your specific project number as the title.

ENTERING A NEW SUBJECT INTO DATA MANAGEMENT

This was outlined above. Name your subject with the non-identifying naming convention S## for full study participants, or P## for pilot study participants.

SYSTEM CALIBRATION

1. Aim MX Cameras

Simply press the “Start” button, and click it again after it has displayed “Stop.”

2. Create MX Camera Masks

For this step, make sure you are in Camera mode and have selected all 10 MX cameras so you can visualize any sources of reflection or other artifacts on the screen; these will appear in a gray color. Click “Start” and click again after it has displayed “Stop.” This can be nearly instantaneous. You will notice that any reflections that were masked appear in a blue shade.

3. Calibrate MX Cameras

You should still be in Camera mode so that you will be able to see the calibration wand (called “5-Marker Wand & L-Frame” in VICON) covering the capture volume once you begin to wave it. Once you press start, you will take the calibration wand and wave it over the entire capture volume until all cameras have calibrated. Utilize a “frying pan” approach when waving the wand, moving it in large circles in both the sagittal and transverse planes. Be sure to cover the entire capture volume, including low to the ground or treadmill!

You will know when calibration is complete because there is a yellow flashing light on each camera while it is calibrating, but when it is finished, the camera will only display its green “on” light. Alternatively, you can tell calibration is complete when all 10 cameras have reached their 2500 wand count minimum at the bottom of the “Tools” pane. The status bar under “MX Camera Calibration Feedback” will begin filling once all cameras have achieved their minimum wand count. It will take several moments (maybe even a minute) for the cameras to finish calibrating.

4. Set Volume Origin

For this step, you will need to place the calibration wand back into the center of the capture volume. For the current setup of the NoBi Lab, the long axis of the wand needs to be oriented such that it points to the front or back of the truss (the short sides of the truss). It should NOT point toward the wall with windows or its opposing wall. Note: if you are using the BAMC 57 marker set, the handle end of the wand needs to point toward the side of the truss that has cameras 7 and 8 (so that exported data will mesh correctly with V3D code for proper data processing). Leave the calibration wand in place for the next step.

5. Calibrate DV Cameras

When you click the “Calibrate DV Cameras” button, the view pane will automatically display the real-time image the DV camera is picking up. Use the mouse to zoom in (mouse click:...) as close as you can to the wand. The image will be very pixilated, and that is just fine. Use the

mouse to click the center of each of the 5 markers on the wand, which we will define to be the brightest possible pixel.

SUBJECT PREPARATION

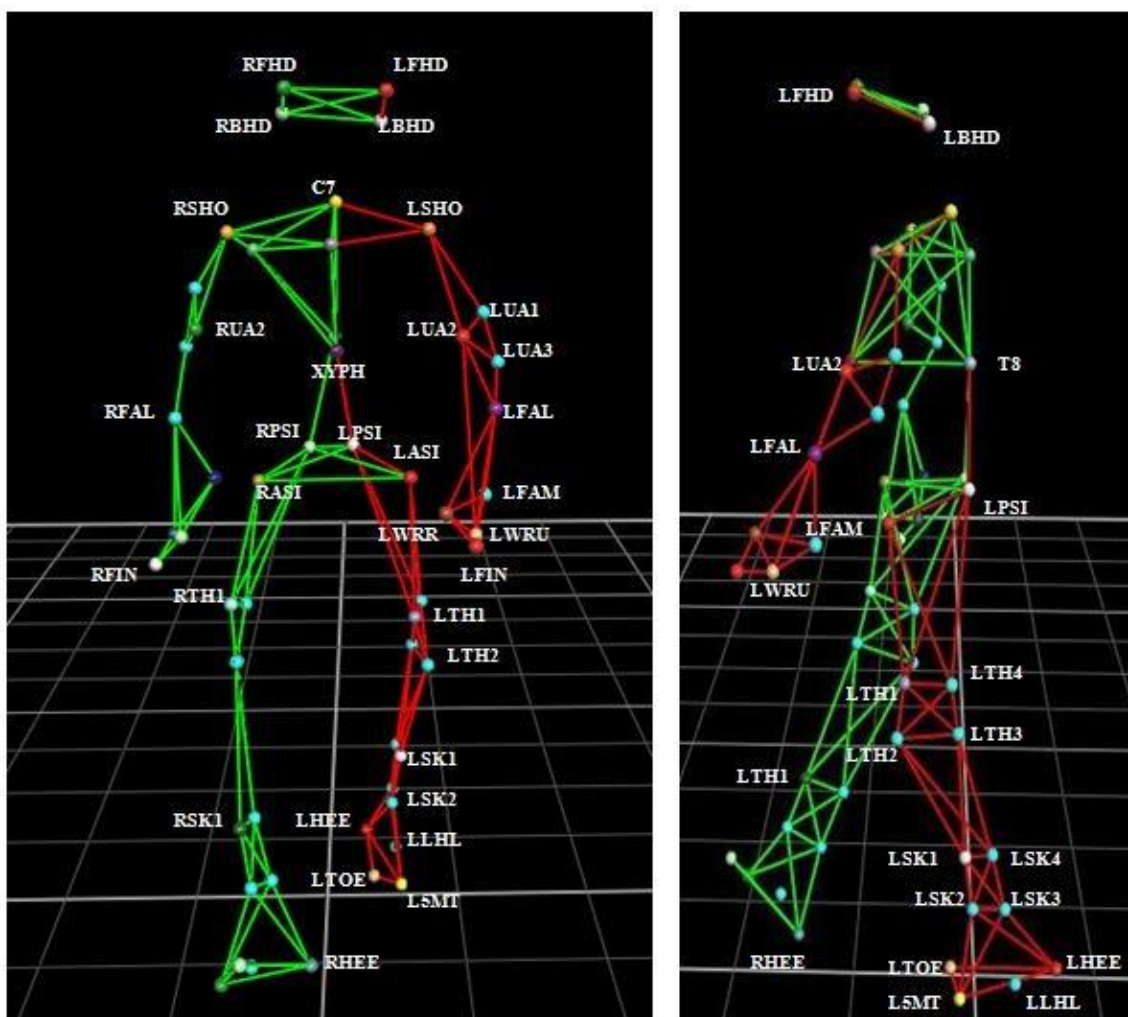
If you are utilizing EMG in your study, apply these to your subject first, as it is easier to place electrodes when you do not already have VICON markers on them. Then apply all markers according to the guidelines set forth in Appendix 1. Collect your calibration trials in the following order:

1. Maximum voluntary contraction trials for EMG.
2. Range of motion trial (with the digitizing wand in the frame).
3. Process the above trial.
4. Static trial (with the digitizing wand in the frame)
5. Relaxed trial (with the digitizing wand in the frame)
6. Digitizing trial (try to stay out of the way so your body does not interfere with the markers on the participant)
7. Use the "BAMC" pipeline operations set to perform the dynamic subject calibration.

CAPTURE

First load the subject from the template. Use the "57 Markers" template when prompted. Set auto-capture parameters if desired. For example, you can set the system to automatically stop a trial after a given time period. Press "Start" to begin collecting. Repeat this process until all of your trials are complete.

Appendix A: Marker Placement for BAMC Standardized Marker Set



Appendix B: List of Video Tutorials

- 1. Starting the VICON System**
- 2. Creating a New Database**
- 3. Calibrating the System**
- 4. Preparing the Participant**
- 5. Capturing Data**
- 6. Labeling and Data Export**

Bibliography

BAMC SOP: CAREN Nexus Processing 20090512 Version # 01. May 2009.

NoBi Lab SOP. May 2008.

www.vicon.com

Vita

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